REMARKS

By the above amendment, Applicants have rewritten Claim 1 to define the invention more particularly and distinctly so as to overcome the technical rejections and define the invention over the prior art.

Claim Rejections – 35 USC § 102

The rejection of claims 1-3, 5-11 and 14-16 under 35 U.S.C. §102(b), as being anticipated by Hockman Re 30,027 is respectfully traversed.

Independent claim 1 has been rewritten as new claim 18 to more particularly point out and distinctly claim the subject matter of the invention in a patentable manner.

Particularly, new claim 18 recites
"elongated reflective surfaces" having "generally concave transversal profiles", "front longitudinal ends" and "opposing rear longitudinal ends" and adds that "at least a substantial part of said reflective surfaces" are designed and positioned "to reflect incident radiant energy" into "a plurality of convergent beams and direct said plurality of said convergent beams to a plurality of converging directions through spaces between adjacent pairs of said rear longitudinal ends". The same applies to dependent claims 2-17.

Claim 18 additionally recites "an elongated energy receiving means" disposed in "immediate energy receiving relationship to each of said reflective surfaces" so that "said convergent energy beams reflected from said reflective surfaces at least partially superimpose on said energy receiving means". Accordingly, the same applies to dependent claims 2-17.

In claims 2-4, 11, 12, and 15-17, the term "mirrored" has been changed to "reflective" so as to be consistent with new claim 18.

The last O.A. stated regarding claims 1-3, 5-10 and 14-16 that Hockman shows in Figs. 4 and 5 a solar collection apparatus including a plurality of spaced apart, parallel concave reflectors (16) which satisfy the claimed types of curves, and separate energy receiving means (tubular absorber 20) receiving energy from the reflectors, wherein the rear ends of the reflectors face the energy receiving means and are inclined towards each other.

Applicants respectfully submit that new claim 18 distinguishes over Hockman under Section 102 because Hockman does not show "elongated reflective surfaces" having "generally concave transversal profiles" and being operable to reflect the incident radiant energy into a **plurality of convergent beams** and direct "said plurality of said convergent beams" to a **plurality of converging directions** through **spaces between** adjacent pairs of "said rear longitudinal ends"

Hockman also does not show "an elongated energy receiving means" being disposed in **immediate** energy receiving relation to each of "said reflective surfaces" and does not teach the superposition of convergent energy beams on "said energy receiving means". The same applies to dependent claims 2-3, 5-10 and 14-16.

Hockman shows a solar radiation collector and concentrator with a longitudinal plurality of aligned curved reflective surfaces being operable to reflect incident solar radiation toward a common focal axis extending longitudinally of an enclosure assembly. A helicoidal fluid-bearing tube longitudinally mounted within the enclosure assembly at the common focal axis of solar radiation reflected from the plurality of reflective surfaces is provided to absorb the collected solar radiation.

The plurality of reflective surfaces shown in Hockman is essentially a multi-stage reflector. It will be appreciated by those skilled in the art that, Hockman's reflective surfaced are positioned so that, while a pair of such adjacent surfaces can be operable to direct solar rays to a helicoidal tube, as a matter of optics, most of incident rays will undergo multiple reflections on these surfaces before reaching the tube, as shown in Fig. 5 in Hockman.

As the reflection coefficient of any reflective surface is always less than 1 (see, e.g., Section 25.2 in Jenkins, F. A. and White, H. E., Fundamentals of Optics, 4E, McGraw-Hill, 1976), solar rays will attenuate at each reflection in Hockman's collector causing the loss of incident energy and hence resulting in an overall low efficiency of the unit and increase of system cost.

Hockman does not teach positioning concave reflective surfaces to directly reflect the incident radiation to a plurality of converging directions through spaces between adjacent surfaces. Instead, most incident solar rays are redirected by Hockman's reflective surfaces (and especially by their upper portions) to an adjacent reflector. In fact, each pair of adjacent reflectors, according to Hockman, acts

as a light guide where one side is concave and the other is convex. It will be appreciated by those skilled in the art that such a nonimaging trumpet-like system generally creates a divergent flux at its exit aperture (see, e.g., Welford, W. T. and Winston R., High collection nonimaging optics, Academic Press, San Diego, 1989). Moreover, a detailed analysis of the ray paths drawn in Fig. 5 shows that, when the law of reflection is considered for the angles of incidence shown, at least some of the uttermost rays entering the entrance aperture of a pair of outer reflective surfaces of Hockman's device will not reach the receiving tube since they will exit back to the entrance aperture.

Furthermore, as taught in Hockman (col. 4, l. 28 and Fig. 5), at least a part of rays reflected from longitudinal reflective surfaces is directed to a secondary convex radiation reflector disposed below the plurality of these surfaces. This further adds in energy losses on multiple reflections and makes the energy flux even more divergent. As a result, a substantial portion of incident radiation may not reach the receiving helicoidal tube.

In this invention, "elongated reflective surfaces" are individually curved and positioned with their front longitudinal ends facing the source of radiant energy and opposing rear ends facing "energy receiving means" and inclined toward one another so that the incident radiant energy is reflected by these surfaces to a plurality of converging directions through spaces between the rear longitudinal ends of adjacent surfaces.

All portions of reflective surfaces of this invention, including their front and rear longitudinal ends, reflect incident rays directly to a receiver with no additional reflections and associated energy losses. As a result, all incident rays impinging the entrance aperture formed by the array of elongated reflective surfaces are reflected to and absorbed by "energy receiving means". It will be understood that, as Fig. 3 of this invention shows, the recited in new claim 18 "elongated reflective surfaces" are designed and positioned so that "said convergent energy beams" reflected from "said reflective surfaces" are directed into spaces between adjacent reflective surfaces and the individual beams remain convergent when exiting from spaces between the adjacent reflective surfaces. It will also be appreciated that this invention also does not utilize any convex shapes to direct the incident radiation to "energy receiving means", while these shapes are inherently required in Hockman to redirect incident radiation to adjacent reflectors and then to the tubular absorber through multiple reflections.

In other words, unlike Hockman's reflectors, each reflective surface of the present invention acts an independent concentrating reflector which illuminates the receiver by a concentrated (convergent) beam directly and forms a focal spot on it utilizing only a single reflection. The individual focal spots at least partially superimpose on one another thus providing an improved energy concentration.

The last O.A. noted (p. 2) that some of the incidence angles in Hockman fall between 45 and 90 degrees. Applicants submit that, as stated above, reflective surfaces of the present invention are operable to reflect the incident radiant energy to a plurality of converging directions through spaces between adjacent reflective surfaces and directly illuminate the receiver with a single reflection. Accordingly, applicants select mutual disposition and alignment of reflective surfaces so that **all** rays from the source are reflected at angles being exclusively in the range between 45° and 90°.

On the contrary, Hockman does not teach a single-stage reflection at these angles. In fact, multiple reflections can result in smaller than 45° angles of incidence, thus Hockman teaches away from arranging the surfaces to reflect at angles greater than 45° and less than 90°. As Hockman shows in Fig. 5, the incident rays reflected from bottom portions of longitudinal reflective surfaces and from a convex radiation reflector of his device do not belong to this optimum range.

The last O.A. (p. 2, last paragraph) states regarding claim 3 that Hockman's reflectors meet the limitation "designed and positioned to minimize screening and shadowing on other said mirrored surfaces" since light is able to impinge on all of the reflectors.

Applicants respectfully disagree with this statement and submit that, as Hockman's Figs. 4 and 5 show, the bottom portions of a substantial part of his reflectors can only be illuminated after one or more reflections. This means that the reflective surfaces in Hockman are screened by each other with respect to the incident flux. In addition, the incident rays impinging on upper portions of Hockman's reflectors are generally redirected to an adjacent reflector which means mutual screening and shadowing on the adjacent surfaces with respect to the concentrated flux. As stated above, it results in energy losses on multiple reflections which hampers the utility of the device.

The last O.A. further states that any specific "design" or "position" which enables this function has not been specified. Applicants submit that this function is enabled in the present invention automatically by positioning and aligning the concave reflective surfaces so that they are operable to reflect the

incident radiation to a plurality of converging directions through spaces between the adjacent surfaces (see Fig. 3 of this invention).

Applicants respectfully disagree with the statement that the orientation of Hockman's mirrors satisfies the angular requirement of claim 11 as shown in Fig. 5. According to the present invention, the energy receiver is positioned with respect to the reflective surfaces according to a relation: $\beta < 90°$ where β is the angle between the direction to the sun and direction to point 32 taken at point 33 (see p. 8, 1. 12 of the specification and Fig. 3).

Hockman does not teach this limitation. As it can be seen from Fig. 5 in Hockman, this angular requirement is not satisfied for a substantial part of reflective surfaces, in particular, for bottom portions of outer surfaces.

Applicants submit that this invention also recites an "energy receiving means" disposed in a manner to benefit from the increased energy concentration and further improve radiant energy collection and conversion thus introducing a novel feature, in combination, and producing new and unexpected results. Particularly, applicants select the disposition of concave reflective surfaces in the manner to reflect the incident energy to a plurality of converging directions and disposition of "energy receiving means" in "immediate energy receiving relation to each of said reflective surfaces" in order to form a common focal spot on the receiver as a superposition of individual focal spots formed by each surface utilizing a single reflection (see p 8, l. 1-2 of specification). This is entirely foreign to Hockman since, as stated, the system of this reference does not teach the corresponding selection of individual surface profiles and does not employ the appropriate disposition of an energy receiving means to intercept the concentrated energy flux directly and in the most favorable fashion.

Thus applicants submit that new claim 18 recites novel physical features, which, in combination, create a new system for collecting and converting radiant energy and hence is patentable under § 102 over Hockman.

Dependent claims 2-17 incorporate all subject matter of claim 18 and add additional matter which, in combination with novel features of claim 18, makes them a fortiori and independently patentable over Hockman.

Claim 2, as amended, additionally recites the slopes of "reflective surfaces" being defined so that angles of incidence α of radiant energy on "said reflective surfaces" have particular values more than 45° and less than 90°. As stated above, Hockman does not teach this limitation.

Claim 3, as amended, additionally recites designing and positioning "reflective surfaces" to minimize screening and shadowing on other "reflective surfaces". As stated above, this is completely foreign to Hockman since this reference employs multiple reflections to illuminate bottom portions of his reflectors and then the receiving helicoidal tube.

Claim 4, as amended, additionally recites one or more planar reflective surfaces which are not shown in Hockman.

Claim 5, as amended, additionally recites at least one "transversal profiles" being formed by a segment of conical section curve. Clearly, Hockman does not teach this limitation. Accordingly, dependent claims 6 and 7 further add that the curve segment can be parabolic or circular.

Claims 8-10, as amended, further recite transversal profiles being formed by a polynomial function, parametric curve or spline, or a set of conjugated lines, accordingly. This is also not taught by Hockman.

Claim 11, as amended, further adds that "energy receiving means is positioned according to a relation: $\beta < 90°$". As stated above, this is also clearly foreign to Hockman.

Claims 12 and 14, as amended, further recite energy receiving means comprising "at least one photovoltaic cell", which can further comprise a "heat sink" (dependent claim 13), or "at least one tubular absorber of a solar heat collector", respectively. As stated above, this feature, in combination with novel features of claim 18, is also novel with applicants and produces new and unexpected results - the improved collection and conversion of radiant energy.

Claim 15, as amended, further recites that "energy receiving means is mechanically separated from said energy concentrator" which is also clearly foreign to Hockman.

Claim 16, as amended, further adds that one or more "reflective surfaces" "is disposed in any one of a translated, a reversed and/or a rotated orientation relative to the others". Hockman does not do this since his longitudinal reflective surfaces are attached to a rigid frame, supported by vertical reflectors and positioned at fixed distances relatively to each other.

Claim 17, as amended, further adds an "axle support means" which is also not shown in Hockman.

Thus, for the above reasons, applicants request reconsideration of the rejection of claims 1-3, 5-11 and 14-16, as now applicable to independent claim 18 and dependent claims 2-3, 5-11 and 14-16, under 35 U.S.C. 102.

Claim Rejections – 35 USC § 103

The rejection of claims 4 and 17 as being unpatentable under 35 U.S.C. §103(a) over Hockman and claims 12 and 13 as being unpatentable under 35 U.S.C. §103(a) over Hockman in view of Cornwall et al of record 5,180,441 is respectfully traversed.

As stated above, claim 1 has been rewritten as new claim 18 to define patentably over Hockman. Also applicants submit that the novel physical features of new claim 18 are also unobvious and hence patentable under §103 since they produce new and unexpected results over Hockman and Cornwall. Dependent claims 4, 17, 12 and 13 incorporate all the subject matter of claim 18 and add additional matters which, in combination with novel features of claim 18, makes them a fortiori and independently patentable over Hockman and Cornwall, or any combination thereof.

Particularly, claim 4, as amended, adds one or more planar reflective surfaces to the apparatus of new claim 18. While planar reflectors are well known in the art, no other references, including Hockman, show them in combination with "reflective surfaces" having generally "concave transversal profiles" and operating in the most efficient manner to collect and convert radiant energy.

Claim 17, as amended, further adds an "axle support means". Similarly, while tracking devices are widely used in connection with energy collectors, this subject matter in combinations with novel features of new claim 18 creates new and unobvious results, particularly, improved energy concentration and collection.

Claim 12 and dependent claim 13 further add "at least one photovoltaic cell" to the apparatus of new claim 18. Accordingly, with new claim 18 being unobvious and patentable over Hockman, these dependent claims are independently patentable under §103(a) over Hockman in view of Cornwell.

Conclusion

In view of all the foregoing reasons, applicants respectfully submit that the claims are now in the proper form and this application is in condition for allowance, and such allowance is earnestly solicited.

Request for Constructive Assistance (MPEP § 2173.02 and § 707.07j):

If the Examiner finds that patentable material is disclosed in this application but the application is not believed to be in full condition for allowance, applicants respectfully requests Examiner's constructive assistance and suggestions in order to place this application in allowable condition without the need of further proceedings.

Respectfully submitted,

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Date Aug. 29, 2003, Signature _____
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